

Commentary

The Value of Water Supply and Sanitation in Development: An Assessment

DANIEL A. OKUN, ScD

Abstract: The attractiveness of oral rehydration therapy (ORT), a new and simple ministration that averts many child deaths from diarrhea among children, is diverting attention among donor agencies from the importance of water supply and sanitation (WS&S) in developing nations.

The principal factor that led to the adoption of ORT is its apparent low cost per diarrheal death averted in children when compared with WS&S. However, WS&S provides many more benefits that are essential to sustaining the lives saved by ORT and vital to maintaining and enhancing the lives of adults and children. Among many other benefits WS&S prevents spread of the causes of diarrhea, controls many other water- and sanitation-related diseases,

releases women from the heavy and time-consuming burden of carrying water from distant sources, and improves the quality of life in the community.

Cost comparisons between WS&S and ORT are misleading. WS&S is a long-term investment in preventive health while ORT is a response to an immediate life-threatening situation. WS&S interventions eliminate unsanitary conditions leading to illness and death while ORT has no effect on the causes of diarrheal morbidity. The costs of WS&S are not high: \$5 to \$10 per capita annually. Without WS&S and hygiene education ORT programs are not likely to effect long-term improvement in child health status. ORT and WS&S programs are complementary; one should not displace the other. (*Am J Public Health* 1988; 78:1463-1467.)

Introduction

In aqua sanitas, "in water is health", led the ancient Romans to invest heavily in public water supply facilities, some of which are still in service. Public water supplies in Western Europe and America resulted in the virtual disappearance of cholera and typhoid before immunizations and other medical measures were introduced. More important, the availability of water supply and sanitation (WS&S) facilities became the hallmark of civilized living. Accordingly, the provision of WS&S facilities in the developing world would seem to need little justification. Yet, WS&S programs are being displaced by the more dramatic "life-saving" ministrations of oral rehydration therapy (ORT).

ORT is the oral administration of a mixture of salt, sugar, and water to sufferers of acute diarrhea. Its appeal stems in large measure from its relative ease of administration. Because of its low cost, apparent simplicity, and the dramatic response it sometimes elicits, ORT has come to be viewed not only as an efficient way of averting child deaths but as the basis for health programs of many international development agencies.

The priority position of ORT as a major health intervention is based on a paper by Drs. Julia Walsh and Kenneth S. Warren of the Rockefeller Foundation¹ who criticized the concept of primary health care incorporated in the Alma Ata Declaration of 1978² as being too comprehensive in scope to be implemented in the face of limited financial resources. Alma Ata included "an adequate supply of safe water and basic sanitation" as well as immunizations, appropriate

treatment, and provision of essential drugs. In its place Walsh and Warren proposed "Selective Primary Health Care" which involves examination of the costs of each separate element of primary health care, whether ORT, or WS&S, and the effectiveness of each in reducing infant mortality. They concluded, after examining all interventions, that the most cost-effective "package" costing about \$200-250 per child death averted would include ORT but that WS&S, costing about \$4,000 per child death averted, should not be included.

ORT has understandably become attractive to agencies such as UNICEF, the World Health Organization (WHO), and the US Agency for International Development (AID) because of its apparent low cost and the instant gratification provided through averting child deaths. Making ORT more widely available is commendable, a moral imperative, akin to providing food during famine. But ORT does not prevent the next epidemic nor does food relieve the next famine.

Unfortunately, the focus on ORT has diverted attention and funds from assessing the causes of diarrheal disease and from other programs essential for sound overall efforts to improve child health including particularly WS&S. In its report in 1986 to the US Congress on its Child Survival program,³ AID omitted water supply. In a recent flyer requesting funds, the US Committee for UNICEF listed four "simple, low-cost techniques" for saving lives, the first of which is ORT, at 10 cents per life saved. WS&S was not mentioned. A description of the WHO Diarrheal Diseases Control Program in the most recent edition of *Maxcy-Rosenau Public Health and Preventive Medicine* mentions WS&S only in passing.⁴

Benefits of Improved Water Supply and Sanitation (WS&S)

The benefits of WS&S interventions are contingent upon active community participation and hygiene education. For the full benefits of WS&S to be realized, more is required than installation of the structures, pumps, and pipes. Years of effort by international agencies in assisting developing countries with the provision of WS&S facilities have demonstrat-

Address reprint requests to Daniel A. Okun, ScD, Kenan Professor of Environmental Engineering, Emeritus, Department of Environmental Sciences and Engineering, School of Public Health, University of North Carolina, CB 7400 Rosenau, Room 105, Chapel Hill, NC 27599-7400. This paper, submitted to the Journal November 16, 1987, was revised and accepted for publication June 3, 1988.

Editor's Note: See also related editorial p 1411 this issue.

ed that community participation in the planning, construction, operation, maintenance, and financing of a project is essential to successful continued performance of the facilities and their use by the people to be served. Africa, Asia, and Latin America are littered with inoperative pumps, wells, pipes, and treatment plants that may have been well conceived at the office of a donor agency and/or a country ministry but fell into disrepair because of the absence of local commitment at all stages of the project. Community participation, including local financing, has been the hallmark of successful sustained projects.⁵ Reductions in diarrheal incidence attributable to hygiene education programs alone were between 14 and 48 per cent in Bangladesh, the United States, and Guatemala.⁶

The provision of an adequate supply of safe water has achieved great success in reducing infectious disease incidence in the industrialized world. Its role in developing countries has been described by McJunkin,⁷ who summarized some 50 studies in water and human health. The proceedings of the Cox's Bazaar Workshop contains some 25 abstracts of papers assessing the relationship between WS&S and health.⁸

The benefits from WS&S programs range far beyond the prevention of diarrheal deaths among children. Improved WS&S addresses the causes of the diarrheas responsible for these deaths and, at the same time, prevents the transmission of other diseases, raises the efficacy of other health interventions, and provides benefits not directly related to health. These benefits are discussed below.

Prevention of Disease

A 1985 WHO study has shown that WS&S programs do have substantial impacts on diarrheal disease morbidity. Esrey, *et al*,^{9,10} report that most studies show beneficial impacts from water supply and sanitation interventions.

WS&S is known to be effective in controlling cholera, typhoid, amebiasis, giardiasis, and a variety of helminthic diseases. One or another of these is likely to be a significant health problem in developing countries suffering from high diarrheal disease rates. For example, improved WS&S in St. Lucia resulted in significant reductions in ascariasis and trichuriasis, along with diarrhea.¹¹ The provision of protected water is particularly effective in controlling schistosomiasis where people are exposed to infested waters during bathing and clothes washing.

Dracunculiasis (guinea worm disease), a debilitating but nonfatal disease that affects 10 to 50 million people in West and Central Africa and Western India, may not impact upon young children but has a high attack rate where it does occur. Transmission depends upon direct contact of infected individuals with water used for drinking, generally in shallow ponds or wells where suitable cyclops species are present. A National Research Council workshop in 1982 concluded that "the most effective means of preventing dracunculiasis has been to provide safe water supplies" and recommended that, because dracunculiasis has been drastically reduced or eliminated as a side benefit of water supplies introduced for other purposes, "there is no need to justify providing safe drinking water solely as a means of eliminating dracunculiasis, only to encourage endemic countries to consider this disease when assigning relative priorities to areas where elimination of the disease would occur in addition to other benefits."¹² Nevertheless, it was estimated that a program to eradicate dracunculiasis would justify an investment of approximately \$6

billion, or \$150 per person at risk, on economic benefits (avoiding the loss of marketable goods) alone.¹²

Infection with trachoma is the leading cause of preventable loss of vision and blindness. An estimated 400 million to 500 million people are afflicted with the disease, with blindness occurring in up to 3 per cent of the population at risk. Spread and severity of the disease are related, *inter alia*, to lack of water and poor hygiene. Personal hygiene using adequate amounts of water also reduces the prevalence of scabies, other skin diseases, and louse-borne and fly-borne diseases.

Improved Primary Health Care

Adequate quantities of safe water and sanitary disposal of excreta are necessary for controlling many local endemic diseases, for maternal and child health care, for preparing safe food, and for treating many common ailments, particularly where fluid intake is essential. The care of young children, particularly when several have diarrhea, is a difficult and time-consuming task made considerably more difficult and time-consuming if adequate quantities of water are not readily available.

Hygiene education is also an element of primary health care and is essential to the effective utilization of WS&S facilities. Nevertheless, the difficulties of providing hygiene education in the absence of adequate WS&S need little elaboration. In the absence of readily available water, the mother, to whom most hygiene education is addressed, is obliged to spend an inordinate amount of time bringing water to the home, leaving little time, energy, or enthusiasm for education. In addition, only small volumes of water can be carried long distances, which further militates against recommended hygiene practices.

Improvements in Nutritional Status

The prevention of diarrheal diseases improves nutrition because: enteric infections decrease food intake and increase metabolic losses; diarrhea produces malabsorption of nutrients; and chronic subclinical enteric disease is associated with impaired intestinal function and with morphological abnormalities of intestinal mucosa. A conclusion of the comprehensive nutrition studies conducted by the Institute of Nutrition of Central America and Panama (INCAP) in Guatemala¹³ is that improvements in WS&S "will aid and enhance other measures tending to ameliorate the population's nutritional status."

Services to Health Centers, Clinics, and Schools

Education of mothers about increased breastfeeding, proper weaning, and other child care practices is most effectively accomplished in hospitals, clinics, health centers, and schools. Such institutions require WS&S facilities. Often the first WS&S facilities in a community are provided for health centers and schools, as both water supply and sanitation are perceived as being essential services for such centers. When a health center or school is being planned, incorporation of WS&S facilities for the community is attractive, as economics of scale render the costs less than if the facilities were planned and built separately.

Time Released for Women

Much has been written about the burden that the lack of WS&S facilities places upon women in the poor areas of the developing world. The time spent in carrying water to the home is substantial. Briscoe¹⁴ has summarized some of the studies which indicate that family members (almost exclusively women) often spend from two to five hours daily

carrying water. Many health care services, such as breast-feeding, supplementary feeding, and household hygiene, as well as the administration of ORT, increase the burden on women.

The provision of an adequate quantity of safe water, preferably in the home or at least at a reasonable distance from the home, would free women for many more rewarding tasks, such as child-caring in illness and in health, education, tending home gardens and animals, and proper food preparation, while reducing the ill effects on lactation and fetal development. The release of women from bondage marks the beginning of their empowerment.

Household Irrigation and Animal Watering

In rural communities, piped water to households is widely used for irrigating garden plots and watering animals. The economic value of this practice varies widely but is often substantial. Moreover, such local food production contributes to improved nutrition.

Promotion of Commercial Activity

The availability of piped water and proper sanitary facilities is a considerable stimulus to the development of household commercial activities, shops, eating places, tourism, small industries, and the like. Such enterprises offer employment and increased local income for the community and in turn provide a firm financial base for supporting the water utility. Strong evidence of the commercial value of piped water has been demonstrated in rural villages in the People's Republic of China.

Strengthening Community Organization

When people are involved with the planning, construction, operation, and financing of their WS&S facilities, they strengthen community organizations which constitute important resources that can be used for other community projects. The lessons learned from such experiences lead to the development of local initiatives for all types of projects through learning how to identify and resolve problems, how to organize for action, and how to raise funds locally.

Support for Other Sectors

Housing programs are not mounted to serve health objectives; adequate housing is an end in itself. Nevertheless, a housing program without WS&S services is inconceivable. In fact, WS&S is viewed as so essential that "sites and services" projects provide WS&S on the site, leaving it to the householder to provide the house itself. WS&S projects associated with housing provide benefits far beyond those that can be measured in terms of reduced child disease morbidity or mortality.

Private industry, on a small scale in rural areas and a larger scale in urban and periurban areas, has a stake in WS&S projects. Joint participation of industry and community in developing WS&S projects reduces the cost to each where industry pays its fair share.

Financial Viability

A distinguishing characteristic of water supply projects is that they have the potential for earning revenue sufficient to operate and maintain the facilities and often to generate a return on capital. In contrast, ORT generally requires continuous contributions of funds from international donors and/or national exchequers.

The conventional wisdom has been that the poor in developing countries cannot afford or will not pay for water service. That they can and will pay is demonstrated in poor

villages and in the poor periurban areas of cities. In the absence of a public water supply, people buy water from distributing vendors at rates per liter as much as 40-fold greater than rates paid by those served by piped water in the same area. The evidence is clear that service from water vendors costs substantially more per month than is paid by customers on piped water systems. The poor may pay as much as 30 per cent of their income for water,¹⁵ where the well-to-do pay less than 2 per cent. In the slums of Lima, the poor paid three times more per month for buying 23 liters per capita per day from vendors as contrasted with the rich who used 152 liters per capita per day from the piped system.¹⁶ Investments in water supply systems will reduce the costs of water service to those dependent on vendors.

When donor agencies compare alternative interventions, the total project costs are not as appropriate a parameter as the funds required in grants or loans. For medical interventions, the funds required at the local level are generally recurring costs and need to be in grants, as user charges are seldom appropriate. For water supply interventions, however, much of the financing can be from loans, with cost recovery from charges.

Improved Quality of Life

The availability of "running water" endows a community with enhanced status. Piped water makes possible a wide range of community amenities: public drinking fountains, laundry and bath houses, swimming pools, animal watering troughs, and so forth. Showers and baths in the home add to the quality of life. The ubiquitous photos of children playing in water are testimony to the pleasure provided by running water.

The role of water in society should not need to be stressed. Its place in civilization is evidenced by the celebratory activities that accompany the first introduction of water supply to a community. An extract from N.J. Bradlee's *History of the Introduction of Pure Water into the City of Boston* described the events following the first flow of water into the city in 1848: "After a moment of silence, shouts rent the air, the bells began to ring, cannons were fired, and rockets streamed across the sky. The scene was one of intense excitement, which it is impossible to describe but which no one can forget."

Water is welcome.

Oral Rehydration Therapy

Rehydration by perfusion of fluids lost during periods of acute and prolonged diarrhea has been practiced for many years, but it was only beginning in the early 1960s that successful field trials in the developing world demonstrated the role of replacement fluids and salts administered orally.¹⁷ In recent years, considerable effort has gone into identifying readily available oral rehydration salts in the community and developing simple procedures and user education programs for their application.

ORT is low cost, is relatively easily administered, and helps with rapid recovery from many previously fatal diarrheas. ORT has been responsible for dramatic reductions in child mortality from diarrheas in Egypt (49 per cent), Bangladesh (67–91 per cent), and India (65 per cent) as well as in Dominica, Haiti and among Apache Indians in the US.¹⁸ Such a dramatically successful remedy must be offered wherever and whenever necessary. A caring society cannot fail to offer this opportunity for life. ORT has understandably become attractive in child survival programs. What is not so

readily demonstrated is why ORT has become *the* primary intervention. The following points characterize the role of ORT, demonstrating why it cannot stand without WS&S:

- ORT is not a primary preventive measure. It is initiated only after an attack of diarrhea. ORT serves as a secondary measure for "damage control".
- While ORT may be effective in preventing diarrheal deaths from dehydration, it cannot be expected to have any significant impact on diarrheal morbidity. In a broader sense control of morbidity may be as important a goal as averting child deaths from diarrhea.
- The life that might be saved by ORT is only saved until the next attack of diarrhea. The conditions responsible for the diarrheas remain; the "saved" child may need to be "saved" again and again unless the environment is improved.
- ORT is not an investment in future public health. To be effective, ORT must be administered *ad infinitum* unless other interventions are introduced. Should the financial or administrative support for ORT falter, the community will be in little better shape than if ORT had never been initiated. "In the long run only sanitation, clean water and food, better nutrition and improved living conditions can reduce the incidence of diarrhea among infants and children."¹⁹
- ORT programs must generally be initiated, organized, and funded by central governments. On the other hand, communities can and have taken the initiative in developing a water supply.
- ORT, if applied without major changes in nutrition, will have little effect on the increasing frailty in the population at risk. Because children may have numerous diarrheal episodes during their first five years, if other interventions are not pursued, an increase in frailty in these impoverished children is bound to occur, which puts them at a greater risk of death than the population of children at large. Resuscitation of children who otherwise would have died thus increases the risk to survivors. The net effect of ORT is, therefore, significantly less than is estimated simply on the basis of deaths averted by the procedure.
- Lastly, because ORT is directed only at averting child mortality from diarrheal diseases, the cost or so-called cost effectiveness of ORT cannot be compared with the cost effectiveness of interventions such as WS&S where child survival from diarrheal disease is only one of a wide range of benefits.

In summary, ORT is an important curative measure, but it should not be the keystone in child health programs. Hirschhorn puts it well when he states in a recent review of ORT: "ORT probably can do only little by itself to assure child survival, but needs integration . . . with other strategies."¹⁸ One necessary element of such strategies is WS&S.

Other Health Interventions

Interventions to improve health can be preventive or curative and they can be directed at a community's health status or they can be directed at selected individuals in the community. Preventive interventions include, for example, immunizations and WS&S. Curative interventions include hospital care and ORT. Community interventions include the

construction of hospitals and WS&S projects, while individual interventions include immunizations and ORT.

Most interventions which address enteric diseases improve the effectiveness of other interventions. For that matter, non-health interventions, such as improved housing, improved education, literacy campaigns, and improved employment opportunities resulting in improved economic status may have a greater impact on health than direct health interventions. Thus, almost all interventions can have a positive impact on enteric disease; some will be direct, some indirect, and some quite incidental.

Single Versus Multiple Interventions

Many diseases of concern in the poorer countries of the developing world, especially the diarrheas, can be transmitted by any of several routes. The importance of considering the several routes of transmission is elegantly demonstrated by Briscoe.²⁰ He cites the studies in Matlab Thana, Bangladesh, in the 1970s where cholera transmission took place via drinking water, ingestion of water in bathing, through contaminated food, and by person-to-person contact. The microbiological data indicated that most transmission would take place through drinking water. Because of transmission through other routes, however, elimination of drinking water as a route through provision of water supply did not effect large reductions in cholera, permitting a conclusion that cholera is not water-borne! Similarly, any other single intervention may appear to be ineffective in reducing disease incidence. Where prior, major interventions are introduced, but without apparent effect, subsequent minor interventions may make a major impact, an impact owing to the earlier intervention.

Mosley has addressed the simplistic approach of assessing the cost effectiveness of single interventions against single diseases.²¹ He concluded that there is "a common failing among many health professionals who are proposing choices among health care strategies. The typical approach is to begin with a specific disease such as diarrhea and then examine the cost-effectiveness of alternative intervention strategies. As is clear from this model, if strategies are selected only on the basis of their benefits in preventing disease-specific deaths, narrowly focused technologies will almost always appear to be far more cost-effective than the broad based program interventions. However, if one is looking beyond disease-specific death prevention to the promotion of survival, the broad based interventions will generally prove more favorable, even when implementation costs are taken into account."

While ORT does not fit Mosley's model for an appropriate intervention, WS&S does.

Costs of Water Supply and Sanitation Projects

While generalized estimates of the costs of ORT can be made,²² the capital and operating costs of WS&S projects inherently vary widely. They depend upon the local rainfall, availability of sources, topography, geography, geology, density of population, pumping requirements, levels of service, costs and availability of material locally, requirements for treatment, costs of labor and power, and the costs of borrowing money.

In connection with the International Drinking Water Supply and Sanitation Decade, WHO collected country estimates of costs for urban and rural WS&S projects.²³ The data are assembled and analyzed in a report for the Water and

Sanitation for Health (WASH) project.²⁴ Annualized costs are based on a 10 per cent discount rate over 20 years. Median annualized costs in 1983, inclusive of O&M, for WS&S facilities consisting of standposts on piped systems and pit privies were about \$9.50 and \$2.50, respectively, or about \$12 per capita per year. Lower cost installations that would take priority would range from \$5 to \$10 annually per capita. Estimates from various other sources,²⁶ including WASH project reports, yield costs for similar facilities ranging from approximately \$5 to \$10 per capita annually. Yard taps, which provide a substantially higher level of service, would increase the cost by about half.²⁷

Because WS&S benefits other sectors as well as health, funds need not come from the health sector alone. The health sector wears the mantle of leadership and should, therefore, take the initiative in seeking funds for WS&S.

Conclusions

International, national, and voluntary public and private agencies throughout the world are committed to programs of primary health care generally and child health and survival particularly. The picture of emaciated children at death's threshold has impressed itself on the conscience of society.

Despite the fact that WS&S programs, when initiated with community participation and accompanied by hygiene education, continue to demonstrate their efficacy in preventing diarrheal diseases, and confer a host of other benefits, the promise of dramatic life-saving by ORT has led to the diminishment of investments in WS&S programs by donor agencies.

ORT has been shown to prevent death from diarrheal diseases simply and at low cost. ORT, however, makes no attempt to cure or prevent disease. Rehydration therapy alleviates the physiological imbalance caused by the disease. Children require ORT many times during their first five years. Each bout of diarrhea renders them more frail and more vulnerable to death, which means the data on the "life-saving" attributes of ORT are overstated.

If, while ORT is being administered, measures are taken to improve WS&S, the prospects for improving child health and averting death are substantially enhanced over either the ministration of ORT or the provision of WS&S alone.

ORT and WS&S should not be compared in monetary terms per death averted because their benefits are so disparate. WS&S costs, while varying widely among communities, amount to \$5 to \$10 per capita annually, or pennies per day for each person benefited.

A reassessment of the role of WS&S appears to be underway. James P. Grant, a strong advocate of ORT, states that, "Diarrhea and allied diseases will recur unless safe water and hygiene practices support the life of the poor."²⁶ WHO now recommends that WS&S be included in national diarrheal disease control programs.²⁷

The real financial constraint to implementing WS&S programs is lack of initial funding. Ample evidence exists to show that in villages and periurban slums of Africa, Asia, and Latin America people are prepared to pay for water service. What is needed is the initial capital investment and means for ensuring effective O&M. Donors can make loans or grants which, with establishment of revolving funds, can help ensure long-term viability of WS&S programs.

ACKNOWLEDGMENTS

This paper was presented at the 115th annual meeting of the American Public Health Association in New Orleans, Louisiana, October 20, 1987, and at the International Health Conference, National Council for International Health, May 20, 1988.

REFERENCES

- Walsh JA, Warren KS: Selective primary health care: an interim strategy for disease control in developing countries. *N Engl J Med* 1979; 301:967-974.
- World Health Organization: Primary health care. Declaration of Alma Ata (USSR). Report of the International Conference on Primary Health Care. Geneva: WHO, 1978.
- US Agency for International Development: Child survival, a second report to Congress on the AID program. Washington, DC: AID, 1986.
- Merson MH, Hogan RC: The WHO diarrheal disease program. *In*: Last JM (ed): Maxcy-Rosenau Public Health and Preventive Medicine, 12th Ed. New York: Appleton, Century & Crofts, 1986; 113-117.
- Hewitt E, Becker S: Cost recovery for water supply: a review of experiences: Water Supply and Urban Development Department, World Bank (draft), 1986.
- Feachem RG: Intervention for the control of diarrhoeal diseases in young children: promotion of personal and domestic hygiene. *Bull WHO* 1984; 62:467-476.
- McJunkin FE: Water and Health. Washington, DC: US Agency for International Development, 1983.
- Briscoe J, Feachem RG, Rahaman MM: Evaluating health impact: water supply, sanitation and hygiene education. UNICEF International Centre for Diarrhoeal Disease Research (Bangladesh) and International Development Research Centre (Canada) 1986.
- Esrey SA, Feachem RG, Hughes JM: Interventions for the control of diarrhoeal diseases in young children: improving water supplies and excreta disposal facilities. *Bull WHO* 1985; 63:757-772.
- Esrey SA, Habicht JP: Epidemiologic evidence for health benefits from improved water and sanitation in developing countries. *Epidemiol Rev* 1986; 8:117-128.
- Henry FJ: Health impact of water and sanitation interventions in St. Lucia. Bangladesh: International Centre for Diarrhoeal Disease Research, 1983.
- National Research Council: Opportunities for control of dracunculiasis: Report of a workshop. Washington, DC: National Academy Press, 1983.
- Torun B: Environmental and educational interventions against diarrhea in Guatemala. *In*: Chen and Scrimshaw (eds): Diarrhea and Nutrition: New York: Plenum Press, 1983.
- Briscoe J: Water and health: selective primary health care revisited. *Am J Public Health* 1984; 74:1009-1013.
- Zaroff B, Okun DA: Water vending in developing countries. *Aqua* 1984; 5:289-295.
- Adrianzen TB, Graham GG: The high cost of being poor—water. *Arch Environ Health* 1974; 28:312-315.
- Hirschhorn N: The treatment of acute diarrhea in children. An historical and physiological perspective. *Am J Clin Nutr* March 1980; 33:637-663.
- Hirschhorn N: Oral rehydration therapy: the programme and the promise. *Ch 20, In*: Child Health and Survival, Cash R, Keusch GT, Lamstein J: (eds): Croom Helm Ltd, 1987.
- Parker RL, Rinehart W, Pietrow T, Doucette L: Oral rehydration therapy for childhood diarrhea. *Popul Rep Baltimore, Series L* 1984; (12)4.
- Briscoe J: Intervention studies and the definition of dominant transmission routes. *Am J Epidemiol* 1984; 120:449-455.
- Mosley WH: The demographic impact of child survival programs. Presented at International Symposium on New Avenues in Health Care Organization: from research to action. Center for Public Health Research, Ministry of Health, Mexico; 1986.
- Shepard DS, Lerman SJ, Cash RA: The cost of an oral rehydration therapy program. WHO Control of Diseases Program. Geneva: WHO, 1985.
- World Health Organization, International Drinking Water Supply and Sanitation Decade, Review of National Progress (as of December 1983). Offset Pub. No. 92. Geneva: WHO, 1986.
- Okun DA: The value of water supply and sanitation in development: an assessment of health-related interventions. WASH Technical Report No. 43, Water and Sanitation for Health Project. Washington, DC: US Agency for International Development, September 1987.
- Lauria D: Water supply in developing countries: capacities, costs and pricing. Presented at 1982 International Conference, National Council for International Health, George Washington University, 1982.
- UNICEF: Annual Report of UN Children's Fund. New York: UNICEF, 1986.
- World Health Organization: Report of the sixth meeting of technical advisory group. Geneva: WHO, 1985.